Identifying the youngest HII regions in the Large Magellanic Cloud

Ju Zhu, Lizhong Zhang, You-Hua Chu, Robert Gruendl

Department of Astronomy, College of Liberal Arts and Sciences, University of Illinois at Urbana-Champaign

Introduction

Massive stars are known to play an important role in energizing the interstellar medium; however, their formation mechanism is still not well understood. In this study, we have identified compact HII regions around massive young stellar objects so that follow-up observations can be made to study how massive stars are formed and how they affect the dynamics of the ambient cloud material in their early lifetime.

Selecting YSO candidates with compact HII region

What we were looking for were compact HII regions around massive young stellar objects (MYSOs). Below are the criteria we want our YSO candidates to meet:

1. Spectral energy distribution with an infrared (IR) excess
   - IR excess suggests the existence of surrounding material. Using Spitzer SAGE survey of the LMC and complementary optical and near-IR images ~270 MYSO candidates were identified.

2. Photometry with U-B<0
   - Photometry with U-B<0 suggests that the star is massive. ~70 of the MYSO candidates are blue and long-slit optical spectra were obtained for 54 of them.

3. Locally enhanced Hα and forbidden line emission
   - Locally enhanced Hα and forbidden line emission indicates the existence of photo-ionized gas around the star. ~½ candidates exhibit this enhanced emission. The spatial extents of the spectral lines and Hα images are used to determine the sizes of the HII regions.

Analyzing physical properties

Only O stars show [OIII] emission lines as O6 stars have [OIII] λ5007 Å/Hα ~1 Using this as a reference, we categorized the YSO candidates into early-O, late-O and B stars.

Results

- Among the massive young stellar object candidates, 8 are categorized as B stars, 11 as late-O stars and 11 as early-O stars.
- The HII regions around early-O stars have the lowest [NII]/Hα ratios, which is consistent with the expectations for hot stars.
- The young compact HII regions can be diagnosed by their high densities and small sizes. Many are identified around late-O stars.
- Early-O stars in general have lower densities in their HII regions, most likely resulting from the action of the powerful stellar winds.

Conclusions

Our study has identified 12 promising MYSOs with compact HII regions. These have been included in a proposal requesting Hubble Space Telescope imaging observations. The high-resolution images will reveal the morphology of the HII regions and whether low-mass stars are formed along with the massive stars. This will allow us to study the formation mechanism of massive stars and how they interact with the ambient medium.